FARMERS' CROP ACREAGE DECISIONS IN THE PRESENCE OF CREDIT CONSTRAINTS: DO DECOUPLED PAYMENTS MATTER?

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Selected Paper Prepared for Presentation at the American Agricultural Economics Association Annual Meeting, Orlando, FL, July 27-29, 2008

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Abstract

While in theory decoupled payments do not distort production decisions, in practice there are several potential coupling mechanisms for these payments. We use farm-level data from Kansas to revisit the issue of how (de)coupled are these supposedly "decoupled" payments by focusing on how they may impact production through credit constraints. In particular, we study how production effects may have differed across farmers with varying levels of debt pressure. Our empirical approach exploits the fact that we can observe the same farm over time (and so can account for the effects of time-constant omitted variables) to study how these payments affected total crop acres, owned acres, and the decisions to plant corn, sorghum, soybeans and wheat. Like previous studies, we find small production effects. Nonetheless our results suggest decoupled payments have potentially distortionary effects on production.

Keywords: decoupled payments; credit constraints.

JEL classification: Q17, Q18.

VERSION: April 28, 2008

1. Introduction

In the late nineteen nineties, the rising costs associated with income support programs and the commitments to limit trade-distorting subsidies motivated a more market-oriented approach to agricultural policy from the United States. On April 4 of 1996, after the longest farm bill debate in history, the Federal Agriculture Improvement and Reform (FAIR) Act of 1996, also known as Freedom to Farm, became law, putting an end to the United States' agricultural policy orientation established during the "New Deal" era.

A major change in commodity programs was included in the FAIR Act's Title I, known as the Agricultural Market Transition Act (AMTA), which replaced the old system of price supports with Production Flexibility Contracts (PFC) – predetermined annual payments for "contract commodities" given to eligible landowners and producers with eligible cropland – to be gradually phased-out during the transition to the next Farm Bill. This effectively decoupled the payments from current market conditions, as payments were based on historical (base) acres and yields and were not tied to current production, prices, or resource use. Authorized by emergency legislation in 1998-2001, *ad hoc* Market Loss Assistance (MLA) payments were made to recipients of PFC payments to compensate them for the loss of markets, effectively doubling the amount of payments given to landowners or producers for the years 1998-1999. While also decoupled, these payments were, however, tied to market prices in that they were a result of poor market conditions. Despite the fact that the FAIR Act decoupled government payments, the extent to which it actually changed U.S. farm policy continues to be debated, a debate which is fostered by the amount of *ad hoc* support and continuation of AMTA (PFC and MLA) payments in the 2002 Farm Bill, as well as the base and yield updates it allowed. In particular, this payment extension raises the classic issues of time consistency and credibility of government policy considered by Kydland and Prescott (1977), as farmers may increase the current acreage in anticipation of further base revisions.

The question of whether decoupled payments affect crop production is important for at least three reasons (Adams *et al.* 2001). First, if the payments increase crop production, and therefore decrease prices and returns, they fall short of meeting one of their main goals, which is to increase farm household income. Second, there may be environmental consequences if the payments affect crop production decisions. Finally, because agricultural policies have non negligible international spillovers, a causal relationship between decoupled payments and crop production would undermine the economic rationale of the WTO's green box category of domestic support.[1]

Our first goal is to revisit the impact of decoupled payments on farmers' acreage decisions in the presence of credit constraints. The existence of credit constraints may thwart the decoupled nature of the payments, in that they may be used to replace or complement outside credit in undertaking investment projects. To see the link between credit constraints and investment decisions, consider the following line of reasoning. Credit markets are characterized by information asymmetries, and agricultural subsidies may provide an additional guarantee to lenders that loans will be repaid in the end of the lending period. This increases the liquidity of a credit-constrained farmer, thereby allowing investment to take place. We assume that farmers with better credit-worthiness are less credit-constrained, as they can provide better collateral in case they default on the loan. In addition, empirical studies suggest that decoupled payments are capitalized into land values, improving the credit-worthiness of farmers when they own land.

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[1] In WTO terminology, subsidies in general are identified by "boxes" which are given the colors of traffic lights: green (permitted), amber (to be reduced), red (forbidden); the Agriculture Agreement has no red box, although domestic support exceeding the reduction commitment levels in the amber box is prohibited. The green box is defined in Annex 2 of the Agriculture Agreement. In order to qualify, green box subsidies must not distort trade, or at most cause minimal distortion, they have to be government-funded, and must not involve price support.

Our second goal is to observe whether the magnitude of the impact of decoupled payments depends on the degree to which farmers are credit-constrained. Our hypothesis is that farmers who are more credit-constrained will exhibit greater acreage responses to decoupled payments. The intuition underlying this hypothesis is that farmers who exhibit greater credit-worthiness should, in principle, have easier access to outside funds to implement their investment plans and more flexibility to react to short-term price shocks. Government payments should play a lesser role in investment decisions for these farmers. All else constant, the acreage effects of decoupled payments should be greater the more credit-constrained the farmers.

Our approach resembles Goodwin and Mishra (2006) while improving on its major shortcoming: the lack of observations on individual farms over time. We use farm-level records from the Kansas Farm Management Association (KFMA) for 1996 through 2001, the period during which the FAIR Act was in place. While previous studies on the effects of AMTA payments on farmers' acreage decisions have employed farm-level data, those data have come mainly from USDA's Agricultural Resource Management Survey (ARMS), and therefore do not contain observations on individual farms over time (see, for example, Goodwin and Mishra 2006, and Key *et al.* 2004). The use of survey data, as pointed out by Goodwin and Mishra, makes it difficult to account for historical values of key variables and complicates the identification of causal effects of policy variables. In the econometric analysis we begin with pooled Ordinary Least Squares (OLS) and then move on to exploit the fact that we can observe the same farm over time and implement a Fixed Effects (FE) estimator which allows us to purge time-constant omitted variables. We compare these results with those obtained from using the OLS estimator.

We proceed as follows. In the next section we review some possible coupling mechanisms of decoupled payments. We then introduce the empirical framework and econometric methods used. The fourth section presents the empirical evaluation of the acreage effects of decoupled payments in the presence of credit constraints. The final section contains a summary of the analysis and offers concluding remarks.

2. Possible Coupling Mechanisms of Decoupled Payments

Decoupled payments are often seen by economists as a mean of providing income support for farmers with minimal distortionary effects. In theory, because the connection between the level of support and current market conditions is assumed away, farmers are allowed to make market-based decisions about which commodities to produce, how much to produce, and whether to produce at all. As such, these payments are not expected to cause distortions on production or trade patterns. In practice, however, decoupled payments may not be "production neutral", and an extensive body of literature has identified several conceivable "coupling" mechanisms of decoupled payments, their relative importance difficult to disentangle. This section explores the possible coupling mechanisms of decoupled payments and further motivates the presence of credit constraints as one such mechanism. Indeed effects can arise through, for example, wealth effects and their impact on farmers' risk aversion or labor choices, expectations about rebasing, farm survival, or credit constraints. While several studies have attempted to measure the distortionary effects of decoupled payments, the overall consensus is that while coupling of decoupled payments is pervasive, its effects are small, with the exception of the impact on land values (Bhaskar and Beghin 2007).

An extensive literature shows that in the presence of uncertainty, decoupled payments increase farmers' wealth, potentially reducing risk aversion and the degree of risk (see, for example, Sandmo 1971, Young and Westcott 2000, and Serra *et al.* 2005, 2006). If farmers' preferences are characterized by decreasing absolute risk aversion (DARA), an increase in wealth implies a reduction in the coefficient of absolute risk aversion, causing them to undertake riskier projects, such as planting riskier crops or expanding production by planting crops on land that would otherwise be viewed as too risky. This effect can be magnified if payments vary inversely with market prices, thereby reducing income variability. Hennessy (1998) classified these effects as wealth and insurance effects of decoupled payments; while the latter effect would not be expected to apply to PFC payments, they could apply to MLA payments, which explicitly provided *assistance* in offsetting the effects of *market loss*. The fundamental question, however, involves the extent to which payments actually shift the wealth of farmers. What could be considered as a large payment may not be so substantial when compared against a farmer's overall wealth, which tends to be quite large for the average U.S. farmer (Goodwin and Mishra 2006, Just 2006). In general, because the necessary amounts of transfers to bring about significant production changes in the presence of risk aversion is quite large, this body of literature is met with skepticism.

Labor choices are also potentially affected by decoupled payments, as the increase in wealth caused by the payments alters farmers' labor-leisure choices, taking them away from production and into more leisurely activities. In addition, decoupled payments may influence labor choices through their influence on the on- and off-farm labor supply decisions. Although the key purpose of decoupled payments is to transfer income to farms while leaving output unchanged, any secondary effects on off-farm work are critical to the financial well-being of the farm household, since the majority of workers on U.S. farms are the operators and their families, who contribute at least two-thirds of the labor hours worked.

Another source of coupling comes through expectations about future revisions to the policy, namely expectations about rebasing. To the extent that farmers expect current production to determine future program benefits, their decisions may be altered by the policy, even when the policy is bestowed via decoupled payments. Baffes and De Gorter (2003) pointed out that as market conditions changed over the duration of the FAIR Act, the government's discretion to change the criteria and payments made them unable to make a binding commitment over time, decreasing government credibility. Goodwin and Mishra (2006) observed that farmers may have anticipated the opportunity to update program parameters such as yield and base, and may not have wanted to move to nontraditional crops or to idling land because they would not want to lose the opportunity to secure an updated base.

Decoupled payments also have the potential to distort markets by affecting farm business survival. Farms receiving high payments per acre could bid up prices of fixed resources, like land, causing low payment per-acre farms to shrink or exit. Payments could effectively raise a farm's net worth, thereby making it less costly to obtain financing when liquidity constraints caused the cost of capital to depend on net worth. If large farms were liquidity constrained and small farms were not, an increase in payment per acre could cause large farms to expand and increase in number, bidding up land prices and causing small farms to shrink and decline in number. Finally, greater payments could make agriculture more profitable relative to other occupations, reducing the incentive to exit farming. By influencing farm business survival, decoupled payments can also affect farm consolidation, *i.e.*, the number of small or family farms relative to large, commercial farms. There is some disagreement in the literature about the direction of this effect.

The theoretical foundations of credit constraints are mainly found in contemporary contract theory, where informational asymmetries between borrowers and lenders lead to unresolved problems of adverse selection, moral hazard, or costly state verification. As a result from the capital market imperfections that arise from these problems, external financing becomes more costly than internal financing. Farms are especially vulnerable to credit constraints because (a) there is a substantial lag between the purchase of inputs and the sale of outputs; (b) farms are highly capital intensive relative to their levels of sales and cash flow; (c) farmers' assets are undiversified and inflexible – held almost exclusively in farm-specific capital, especially land; (d) the direct link between private wealth and farm capital limits the possibilities for providing collateral; (e) debt is important as a source of investment funds to a lack of well developed equity markets, and (f) most farms are relatively small (Blancard *et al.* 2006, Bierlen *et al.* 1998). As decoupled payments may increase the liquidity of credit-constrained farmers, they may lead to investment in production that otherwise would not occur. Payments may also provide additional guarantee to lenders that loans will be repaid in the end of the lending period, so that they may obtain more credit or under better conditions than otherwise. The impact of decoupled payments in the presence of credit constraints is studied by Roe *et al.* (2002) and Goodwin and Mishra (2006), who find very modest effects of decoupled payments on resource allocation and production. Goodwin and Mishra's results imply that decoupled payments have only modest effects on acreage, a fact the authors took to be not surprising given that payments, although large and decoupled, represent relatively small changes in the overall wealth of the average Corn Belt farm (an average of 1.8 percent of the farms' net worth). Their analysis, however, is limited by their reliance on ARMS data, which does not contain observations on individual farms over time. Using a three-sector general equilibrium model of the US economy Roe *et al.* observe that decoupled payments affect only land values and rental rates.

Decoupled payments appear to have their greatest impact on land values and rental rates (Bhaskar and Beghin 2007, Abler and Blandford 2007, 2005). Because they are based on historical acres, decoupled payments are capitalized into the value of land and passed-through to landowners via higher land rents and land values, many of whom not the actual operators of the land. For example, the 2003 Report of the Commission on the Application of Payment Limitations for Agriculture asserted that total government payments in recent years increased U.S. farmland values by 15 to 25 percent. The report also indicated that about 41 percent of all farmland was rented out by landowners who did not operate the farms themselves, even though they might share the risk of production through crop share rental agreements.

3. Theoretical and Empirical Framework

The basic contribution of our paper is to connect the influence of AMTA payments on farmers' acreage decisions to their level of leverage. We study this influence controlling for unobserved time-invariant differences across farms and unobserved time effects. We begin this section by motivating the elements that should be included in the estimating equation and then proceed to introduce the empirical approach to estimating this equation.

3.1. Theoretical Model

Suppose farmers choose planted acres to maximize their expected utility of wealth, where wealth is defined by initial wealth, profits derived from production, government payments, and non-farm activities. Following Chavas and Holt (1990) the farmers' problem can be stated as follows:

(1) $$\max_{\{Acres_j\}}\left\{EU\left[W_{t-1}+P_{jt}Y_{jt}\left(Acres_{jt-1},\varepsilon_t\right)\cdot A_{jt}-\sum_{k=1}^{K}c_{kt}Acres_{jt}+G_t\right]\right\},$$

where W_{t-1} is initial wealth, P_{jt} is the price received for the jth crop, $Y_{jt}(\cdot)$ is the per acre output of the jth crop, assumed to be a function of lagged acreage (A_{jt-1} representing rotational issues) and an exogenous shock ε_t, c_{kt} is the per acre cost of input *k*, and G_t represents government payments. We now motivate the variables that should be present in the reduced-form estimating equation.

Crop acres should depend on a set of factors specific to the land including, for example, land quality, in terms of fertility and in terms of moisture content, land accessibility, and the variability and type of weather pattern in the area where the farm is located. Other important factors should include the characteristics of the farm itself, such as the experience or skill of the operators, or the resources available, such as labor or equipment.

The financial resources of the farm should also affect acreage choice. For example, when facing changes in opportunities for profit, the farmer may opt to add or subtract acres, by buying or selling or by renting in or out, or to explore already available acres in a different fashion, for example by changing the crop mix or the application rates of inputs such as pesticides, water and fertilizer. How the farmer deals with these opportunities depends largely on liquidity, both stated and implied. By stated liquidity we mean the actual funds the farmer has available, while by implied liquidity we mean how the financial channels view the default probability of the farmer and thus affect the availability of credit. A farmer with a higher default probability will be viewed as a greater risk by the financial agent, and will either be denied credit or be given credit under less favorable conditions than a farmer with a smaller default probability.

The motivation for our analysis is that government transfers, and decoupled payments in particular, may help farmers make additional investments (in acreage and/or equipment or labor), or take the place of higher-interest bearing loans in the sources of funds of the farm. In addition to having acreage effects *per se*, the effects of these payments may vary depending on the financial status (leverage) of the farm. Naturally, decoupled payments may also impact farmers' risk aversion characteristics, labor choices, or collateral in case they own land, for example.

Hence, the acreage equation should include variables related to the farm, to its financial situation, and to the amount of decoupled payments it receives. A reduced form acreage equation can be defined by the following set of variables:

(2) $$Acres_{ict} = \{\mathbf{Farm}_{ict}, \mathbf{FV}_{ict}, \mathbf{GP}_{ict}\},$$

where the subscripts *i*, *c*, and *t* index the ith farm in county *c* at time *t*, $Acres_{ict}$ denotes crop acres, $\mathbf{Farm}_{ict}$ is a vector of farm characteristics, $\mathbf{FV}_{ict}$ is a vector of financial variables, and $\mathbf{GP}_{ict}$ is a vector of government payments.

3.2. Empirical Specification

Following Chavas and Holt (1990) we include the farm's level of wealth in our estimating equation as part of the farm characteristics vector. While accounting for differing risk responses and general wealth effects, wealth simultaneously characterizes the availability of internal funds versus the need to borrow capital, and provides information about the credit-worthiness of the farm. To capture the notion of "initial" wealth, we use the previous period's wealth. To prevent double counting of payments we subtract AMTA payments receipts from total farm wealth.

The measure of how credit-constrained is a farmer is given by the debt to asset ratio, also known as "leverage." Because greater values of leverage indicate lower credit-worthiness, farmers who are more credit constrained should have smaller acreage responses to market stimuli and greater responses to decoupled payments. Hence we expect greater debt to asset ratios to have a negative effect on planted acres. Note, however, that as pointed out by Goodwin and Mishra (2006), one could potentially question the extent to which the debt to asset ratio variable is endogenous to production decisions. If farmers are borrowing to finance more production, all else constant, the debt to asset ratio is growing with acreage, violating the exogeneity assumption. On the other hand, if one is willing to accept that assets may be growing due to intensified investment, then the growth in both the numerator and denominator could potentially leave the ratio unchanged. We leave this issue for future work.

We represent the degree of decoupled support by considering the amount of AMTA payments received by the farmers. Unfortunately, we are unable to observe this figure directly because the KFMA reports only the total amount of government payments the farms receive, which include PFC payments, MLA payments, Conservation Reserve Program (CRP) payments, Oilseed payments, Loan Deficiency Payments (LDP's), and Marketing Loan payments. Therefore, we estimate the amount of AMTA payments received by the farmers and use this as our measure of decoupled payments.[2] For the years in the sample, estimated AMTA payments include PFC payments and MLA payments for corn, sorghum and wheat. We should point out our inability to distinguish between the effects of PFC and MLA payments. Although we would like to observe whether unexpected decoupled payments affected acres planting decisions any differently than expected payments, there isn't sufficient variation in our sample to separately identify the effects of unexpected payments. Because we also have hypothesized that farmers who are more credit constrained respond differently to decoupled payments, we allow farmers to exhibit differing responses to payments according to their degree of financial leverage by including an interaction term between the decoupled payments variable and the debt to asset

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[2] We defer the explanation of the estimation of AMTA payments to the Data section.

ratio. Hence, the overall effect of decoupled payments depends on parameters involving a direct effect and the interaction effect with leverage.

The estimating equation is given by:

$$
(3) \quad \begin{aligned} Acres_{ict} &= \beta_0 + \beta_1 Size_{ict-1} + \beta_2 Wealth_{ict-1} + \beta_3 DAR_{ict} + \beta_4 GP_{ict} + \\ &+ \beta_5 DAR_{ict} * GP_{ict} + \delta_1 t + \delta_2 c + \delta_3 t * c + \eta_{ic} + u_{ict} \end{aligned},
$$

where $Wealth_{ict-1}$ is initial wealth, DAR_{ict} is the debt to asset ratio, GP_{ict} is decoupled or AMTA payments (total PFC and MLA), and $Size_{ict-1}$ measures lagged farm size (total operated acres). Unobserved factors that have the same influence on acres for all farms are captured by a set of county dummy variables *c*, along with year dummy variables *t*.[3] These fixed effects represent, for example, price risk, which we assume constant across all farms in the county in a given year, systemic yield risk, and weather, along with other unobservable factors that may be relevant to production. We further allow these unobserved factors to vary between county and year by introducing an interaction term between them.[4]

The error term can be decomposed into two components, the time-invariant unobserved factors that cause acres to vary from year to year in each county (η_{ic}), and the idiosyncratic term (u_{ict}). The composite error, $\eta_{ic} + u_{ict}$, draws attention to how the covariance matrix is estimated. The correction procedure suggested by Moulton (1986) allows each county-year group to have a different and unrestricted covariance structure but assumes the errors are uncorrelated across groups. We are thus assuming that farms within a county-year "cluster" are correlated as a result

[3] The county dummy variables are included only in the OLS specifications.
[4] Note that unlike, for example, Chavas and Holt (1991), we do not introduce a measure of market returns (prices) in our estimating equation of total crop acres. There are two reasons for this. First, in the OLS equations, because prices are essentially the same within counties, and only vary between counties if the market price is below the pre-defined county-level loan rate, the county dummy variables capture these effects. Second, because there is so little variability in prices, their effect is picked up by the yearly dummy variables in the FE estimator.

of the unobserved cluster effect η_{ic}. We further specify the Huber-White-sandwich estimator of variance, so that reported standard errors are robust to heteroscedasticity.

The two coefficients of interest are β_4, the *ceteris paribus* marginal acreage effect of decoupled government payments, and β_5, the impact of leverage on the marginal effect of government payments. If government payments are not truly decoupled, we would expect to find a significant positive coefficient for β_4. If government payments have greater acreage effects the more leveraged the farms (the more credit-constrained), we would also expect to find a significant positive coefficient for β_5.

A fundamental assumption necessary for consistency of the OLS estimator is that there is no feedback from current or past shocks to current values of the regressors, or if explanatory variables are strictly exogenous given η_{ic}:

$$(4) \qquad E\left[u_{ict} \mid \mathbf{Farm}_{ict}, \mathbf{FV}_{ict}, \mathbf{GP}_{ict}, \eta_{ct}\right] = 0, \quad t = 1,...,T .$$

We further expect much of the remaining variation in acreage decisions to be explained by unobserved characteristics of the farms, such as the accessibility of the farm or the skill of the operator. If this unobserved heterogeneity is correlated with any variable in $\mathbf{Farm}_{ict}$, $\mathbf{FV}_{ict}$, or $\mathbf{GP}_{ict}$, equation (4) is violated and we have an endogeneity problem. To account for the possible correlation between the unobserved heterogeneity and the regressors we specify the following alternative equation with a farm-specific fixed effect a_i:

$$(5) \qquad \begin{aligned} Acres_{ict} &= \beta_0 + \beta_1 Size_{ict-1} + \beta_2 Wealth_{ict-1} + \beta_3 DAR_{ict} + \beta_4 GP_{ict} + \\ &+ \beta_5 DAR_{ict} * GP_{ict} + \delta_1 t + \delta_2 c + \delta_3 t * c + a_i + \eta_{ic} + u_{ict} \end{aligned},$$

and for consistency we now require:

(6) $$E\left[u_{ict} \mid \mathbf{Farm}_{ict}, \mathbf{FV}_{ict}, \mathbf{GP}_{ict}, \eta_{ct}, a_i\right] = 0, \quad t = 1,\ldots,T,$$

which implies that once $\mathbf{Farm}_{ict}$, $\mathbf{FV}_{ict}$, $\mathbf{GP}_{ict}$, and the unobserved heterogeneity are controlled for, the variables in $\mathbf{Farm}_{ics}$, $\mathbf{FV}_{ics}$, or $\mathbf{GP}_{ics}$, have no partial effect on $Acres_{ict}$, $s \neq t$. The FE estimator allows us to purge the time-invariant unobserved heterogeneity (a_i) from the model by subtracting from each observation the time-average value for that variable, so that the final expression is time demeaned. While this approach drops any time invariant regressors, including the county dummies, the county-year interaction dummy variables account for events that have particular effects on any given counties in any given year.

4. Application: KFMA farms, 1996 – 2001 (FAIR Act period)

4.1. Data

Our analysis is conducted using individual farm data collected by the Kansas Farm Management Association (KFMA) for 1996 through 2001, the period during which the FAIR Act was in place, along with previous years of data for these farms to define some lagged variables in the analysis. Of these, between 712 and 807 farms per year grow dryland crops (an average of about 67.48 percent). The KFMA farms are full-time commercial operations mainly representative of farms with gross sales exceeding $100,000. Of the 61,593 farms counted in the 1997 Agricultural Census, 13,436 farms had gross sales exceeding that number (21.81 percent). The KFMA farms represent, according to Albright (2001), the various farming areas and farm types in Kansas. Our data constitute an unbalanced panel containing 6,796 observations, ranging from 993 farms in 2001 to 1249 farms in 1996. We have information on 830 farms for the six years of the FAIR Act.

The KFMA micro data are supplemented with more highly-aggregated data from a variety of sources. County-level yields come from USDA's National Agricultural Statistics Service (NASS). Country-level rates for PFC and MLA payments (AMTA payments), and county-level Loan Deficiency Payment (LDP) rates come from unpublished USDA data. All nominal variables are converted to real terms by dividing by the Production Price Index for All Commodities published by the Bureau of Labor Statistics (2000=100).

While the KFMA collects information on the total amount of government payments the farms receive, which include PFC payments, MLA payments, Conservation Reserve Program (CRP) payments, Oilseed payments, Loan Deficiency Payments (LDP's), and Marketing Loan payments, only a single aggregate figure is reported. So we have to estimate the amount of AMTA payments received by the farms. For the years in the sample, estimated AMTA payments include PFC payments and MLA payments for corn, sorghum and wheat. Recall the 1996 Farm bill allocated PFC payments to farms based on their payment quantity of the contract commodity (the product of the farm's program payment yield for that commodity, times 85 percent of the contract acreage, or base acres). The annual payment rate for a contract commodity was then multiplied by each farm's payment quantity for that commodity. So, PFC payments for farmer *j*'s ith commodity (PFC_{ijt}) are given by $PFC_{ijt} = 0.85 * bacres_{ij} * byield_{ij} * PFCrate_{it}$, where $bacres_{ij}$ is farmer j's contract acreage of the ith commodity, $byield_{ij}$ is farmer j's payment yield of that commodity, and $PFCrate_{it}$ is the annual national payment rate for the commodity. The sum of these payments across contract commodities is the farm's annual payment.

MLA payments were made to recipients of PFC payments following the same formulae used to calculate PFC payments (but with different payment rates). We follow Serra *et al.* (2006) in approximating payment yields and contract acreage by the 1986-88 average yields and acres.

Total estimated AMTA payments are then obtained by summing over the expected PFC and MLA payments. When this total exceeds the reported government payments in the KFMA data, the inconsistent estimate is replaced by total reported payments. This happens to about 21 percent of the observations.[5] One limitation of our data is that we cannot monitor whether farmers changed bases over time, by buying or selling land enrolled in the program, which could cause a change in government payments received over time other than that brought about by changing rates. While we recognize the problem, we assume that for each acre sold, another acre was bought, so that it is not clear whether such transactions led to more or less planted acres.

Our measure of wealth is obtained by subtracting total debts from self-assessed total assets. Total debts include current liabilities and current, intermediate, and long term loans, plus accrued farm expenses, such as labor hired, interest, machine hire, property tax, and crop insurance. In order to prevent double counting of AMTA payments, we subtract AMTA payment receipts from our measure of wealth, as in Goodwin and Mishra (2006). The degree to which farms are constrained by credit is given by the debt to asset ratio, calculated by dividing total liabilities by total assets.

Following a tradition set forth by Gardner, we use futures prices to calculate expected prices for corn, soybeans, and wheat. These are the daily average prices registered during the planting season for the harvest month contract, where the seasons are defined as the usual state planting and harvesting times found in the USDA's 1997 publication of "Usual Planting and Harvesting Dates for U.S. Field Crops". Because futures prices come from the Chicago Board of Trade, in Illinois, expected prices for corn, soybeans and wheat are corrected by multiplying the

[5] Serra *et al.* (2006) report a statistic of 7 percent. However, they use data from 1998 through 2001, and on a balanced of 596 farms. If we drop 1996 and 1997 data from our sample, this number decreases to 16 percent. This number further drops to 14 percent for our balanced panel of 855 farms.

crop's futures prices by a regional adjustment factor (regional basis), so that expected prices are given by $EP_{i,t} = \theta \cdot P_{i,harvest|planting,t}$, i = corn, wheat, soybeans. The basis is defined as $\theta = \frac{1}{x}\sum_{s=1}^{x}\frac{P_{i,Kansas,t-s}}{P_{i,Illinois,t-s}}$, i = corn, wheat, soybeans, where x is the number of previous years involved in the calculation. The best regional correction was judged by the squared difference between the actual year price reported by NASS and the estimated price based on the futures contracts. The differences suggested the best basis is given by the previous year's ratio of state prices for corn, by the five previous years' average of the ratio of state prices for soybeans, and by no correction for wheat. Since there is no futures market for sorghum, expected sorghum prices are calculated by multiplying the average monthly price at planting time by the five year average of the ratio between monthly average price at harvest time and the monthly average price at planting time, so that expected sorghum prices are given by $EP_{sorg,t} = P_{sorg,planting,t} \cdot \frac{1}{5}\sum_{s=1}^{5}\frac{P_{sorg,harvest,t-s}}{P_{sorg,planting,t-s}}$. Because under the 1996 Farm Bill, corn, sorghum, soybean and wheat producers were eligible for loan deficiency payments (defined by the difference between the county loan rate and the posted county price when this price was below the loan rate), these payments effectively created a floor for the price farmers could receive. Expected crop prices for all four crops were then calculated as the maximum of the commodity county loan rate ($LoanRate_{ict}$) and the expected market price calculated above, $EP_{i,t} = \max(EP_{i,t}, LoanRate_{i,c,t})$, i = corn, sorghum, soybeans, and wheat. Note, however, that for the years 1996 and 1997 the reference loan rate used was the national rate, not the county loan rate.

During this period, the size of the farms in the KFMA increased, mainly through an increase in owned acres. The crop mix also changed, with corn and soybeans acres increasing while wheat and sorghum acres decreased. At the same time, decoupled payments receipts increased by about 1.6 times. Table 1 contains the variable definitions and some summary statistics.

4.2. Empirical Results

Our empirical analysis is conducted in three segments, as we explore how AMTA payments affect the farmers' crop acreage decisions by analyzing how they affected total (owned and rented) crop acres, owned crop acres, and the decisions to plant corn, sorghum, soybeans and wheat.

4.2.1. Total Crop Acres

Table 2 reports the results of the OLS and FE parameter estimates for the total (owned and rented) crop acres LHS variable. We report results for different versions of these estimators, which vary in the dummy variables included. We estimate three versions of the OLS specification, which appear in columns (1) through (3). Column (1) includes the results of estimating without dummy variables, column (2) includes year and county dummies, and column (3) includes year, county, and year-county interaction dummies. We also estimate two versions of the FE estimator, the first including year dummies, in column (4), and the second including year and year-county interaction dummies, in column (5).

Controlling for time-invariant effects has a major impact on the magnitude of most of the coefficients. The debt to asset coefficient actually changes sign, becoming significantly negative in the FE estimators, thereby conforming to the expected sign. AMTA payments do affect acreage decisions, but less so in the FE estimators. Not acknowledging the presence of unobserved time-invariant heterogeneity suggests a $1,000 transfer in AMTA payments raises crop acres from about 20 to 23 acres. This estimate decreases to a 4 to 5 acre increase when we move to the FE estimator. These coefficients imply elasticities (without incorporating the interaction term) ranging from 0.055 and 0.366 in the FE specification with year dummy variables and the OLS specification without dummy variables. When we take into consideration the possibility of events which affect particular counties in particular years, the elasticities increase to 0.074 in the FE estimator and decrease to 0.318 in the OLS estimator. These payments, however, do not seem to have a differential effect on farmers who are more credit constrained, as the interaction term is never significant. The total acres elasticity of AMTA payments considering the interaction term is very similar, varying between 0.320 and 0.362 for the OLS estimators with year and county dummy variables and without dummy variables, respectively, and between 0.068 and 0.082 for the FE estimator without and with dummy variables.

4.2.2. Owned Acres

Empirical work suggests that given the importance of the rental market for land, the most important effect of AMTA payments was to increase the value of the principal fixed asset in agriculture, land. For farmers who wanted to expand crop acres, this may have motivated the purchase of additional land, instead of renting. Goodwin and Mishra's (2006) results, for example, suggested AMTA payments could lead to more ownership transactions. We now investigate whether AMTA payments explain the variation in owned planted acres, and maintain our additional hypothesis that payments matter the more highly leveraged the farmer. Our estimating equation is identical to equation (5), but our dependent variable is now owned crop acres instead of total (owned and rented) crop acres.

Table 3 presents the results. These share some features of those of total (owned and rented) crop acres, although they differ in three ways. First, the debt to asset ratio has a positive coefficient across the estimators and their different specifications, although it is not significant except for the FE estimator using year dummy variables. This result suggests that the degree to which farms are credit-constrained does not affect the farmers' owned crop acres, while at the same time questions the extent to which leverage is endogenous to acreage, as farmers may be borrowing to finance more production in owned land.

Second, the coefficient estimates for AMTA payments change signs between estimators, being positive and significant in the OLS estimators and negative and insignificant in the FE estimators. The owned acres elasticity of AMTA payments without the interaction term is somewhat lower than in the total acres equation, varying between 0.097 and 0.139 for the two OLS estimators with and without dummy variables. Finally, and most importantly, the interaction term between AMTA payments and the debt to asset ratio is positive and significant across the three estimators and their different specifications. These positive significant coefficients on the interaction term suggest that AMTA payments boost the purchase of crop acres for more highly leveraged farmers. The owned acres elasticity of AMTA payments considering the interaction term is now between 0.250 and 0.257 for the OLS estimators with year and county dummy variables and without dummy variables, respectively, and between 0.0003 and 0.028 for the FE estimator with and without the year-county interactions. These elasticities are much lower than those found for the total crop acres case since AMTA payments do not appear to have a direct impact on own acres. Our results suggest their biggest impact is on the more highly leveraged farmer, supporting our second hypothesis that AMTA payments matter more for the more leveraged farmers. It is possible that these payments improve the collateral of the more credit constrained farmers, allowing them to purchase land. This additional land also serves as collateral, one whose value increases due to the distribution of decoupled payments, as suggested in previous work.

4.2.3. Crop specific equations

So far our analysis has considered the global impact of AMTA payments on planted acres, and has ignored potential effects upon the farmers' choice of crop mix. Our goal in this section is to observe how decoupled payments affect the planted acreage of specific crops, namely corn, sorghum, soybeans, and wheat. Over the duration of the FAIR Act, the average farm in our sample increased its planted acres of corn and soybeans, both by about 40 percent, while acres planted to sorghum and wheat decreased by 12 and 6 percent, respectively.

The framework for evaluating the effect of decoupled payments on the planted acreage of corn, sorghum, soybeans, and wheat is the one presented before. Acreage is still a function of farm characteristics, financial variables, and government payments. However, we now include expected prices in the estimation and drop the use of year dummy variables. For each crop the basic estimating equation is given by:

$$\text{(7)} \quad \begin{aligned} Acres_{jict} = {} & \beta_0 + \beta_1 Size_{ict-1} + \beta_2 E\,\text{Price}_{jict} + \delta_k \sum\nolimits_{k=1}^{3} E\,\text{Price}_{kict} + \beta_3 Wealth_{ict-1} + \\ & \beta_4 DAR_{ict} + \beta_5 GP_{ict} + \beta_6 DAR_{ict} * GP_{ict} + u_{ict} \end{aligned},$$

where the acres planted of the jth crop ($Acres_{jict}$) are a function of expected prices of the crop ($E\,\text{Price}_{jict}$) and the alternative crops ($E\,\text{Price}_{kict}$, k = *1, 2, 3*), and the farm characteristics, financial variables, and government payment variables defined earlier. The coefficients of interest are now β_5, the marginal acreage effect of AMTA payments, and β_6, the impact of leverage on the marginal effect of AMTA payments. As before, we expect to find positive coefficients on these regressors, indicating the presence of wealth effects from AMTA payments, and how their effect depends on the degree to which farms are constrained by credit. We again estimate the commodity equations using OLS and FE.

Table 4 contains the parameter estimates and summary statistics of the estimation. The own price effects are negative for corn in both estimators and for sorghum using the FE estimator. These effects are positive for soybeans and wheat, and significantly so for the latter crop. Except for soybeans, where changing estimators changes the sign of the coefficient, and following what happened with total crop acres and owned acres, the direct effect of AMTA payments decreases when we take into account unobserved time-invariant factors. The coefficient remains positive and significant for corn but loses significance for sorghum, and actually becomes negative for wheat, where AMTA payments go from having a very large impact to a negligible one. These effects are, however, very small. In the FE estimator, a $1,000 transfer in AMTA payments increases corn and soybeans by about 1.3 acres. The associated elasticities range from 0.4182 to 0.6282 for corn and wheat in the OLS estimator, and 0.1173 and 0.1582 for soybeans and corn in the FE estimator. These values are much greater than those of Goodwin and Mishra (2006), who reported an elasticity of 0.0317 for corn and 0.0204 for soybeans (and a positive elasticity of 0.0428 for wheat). These elasticities are also much greater than those from the total crop acres estimation using the same FE estimator. Meanwhile, any effects of leverage appear to be absorbed by the farm-specific fixed effects. In the FE model, the positive significance for corn and negative significance for wheat disappears. The full AMTA payments elasticities of specific crops acres now range from 0.1624 for soybeans and 0.1824 for corn.

Finally, notice that our finding that AMTA payments matter for corn and soybeans is consistent with the observed increases in corn and soybeans acres, and decreases in sorghum and wheat acres. When we account for unobserved time-invariant heterogeneity, AMTA payments had significant positive acreage effects for those commodities whose planted acres increased over the period of the FAIR Act, corn and soybeans, and negligible effects for those whose planted acres decreased, sorghum and wheat.

5. Concluding comments

According to the U.S. General Accounting Office, during the first four fiscal years of the Farm Security and Rural Investment Act of 2002, farmers received approximately $60 billion in federal program payments from the U.S. Department of Agriculture (USDA). Due to unexpectedly weak commodity prices, the 2002 Farm Bill, originally expected to cost about $170 billion over the following 10 years, pushed the total price tag to $190 billion. These rising costs have significant effects at the national and international levels. At the national level, higher costs increase budgetary pressure. This effect is magnified by increases in production induced by payments. That is, if support payments stimulate production, prices decrease, requiring an even greater level of support in order to maintain the desired level of farm income. A second issue is that heterogeneity within the farm sector results in an unbalanced distribution of payments, so that most of the transfers do not reach small farms. In 2004, the largest 7.5 percent of farms in terms of gross receipts received 56 percent of all government payments (USDA). Hence, the improvement in family farm income, the stated goal of these policies, is not met, creating additional discontent with the policy. A commonly-cited perverse outcome is that recipients of Farm Bill payments include, among others, TV host David Letterman and former NBA star

Scottie Pippen, neither of whom need the additional income, presumably.[6] There may also be environmental consequences or other externalities if the payments affect crop production decisions. At the international level, increased spending on agricultural support payments does not seem compatible with the multilateral commitments made under the World Trade Organization (WTO) to limit trade-distorting agricultural support. This has been highlighted by recent trade disputes in the WTO. For example, in September of 2002, at a meeting of the Dispute Settlement Body of the WTO, Brazil claimed that U.S. cotton subsidies were depressing world prices and injuring Brazilian growers. A similar claim was made about the European Union's sugar subsidies. Two years later the WTO panel decided in favor of Brazil, deeming U.S. support to cotton producers as trade-distorting. A similar decision was reached for sugar.

The literature has identified several possible coupling mechanisms of decoupled payments. Decoupled payments may affect production through, for example, wealth effects and their impact on farmers' risk aversion or labor choices, expectations about future revisions of policy, or credit constraints. The overall consensus, however, is that with the exception of land values, decoupled payments' effects, when measurable, are small. Our goal was to revisit the impact of decoupled payments in the presence of credit constraints. The idea is that decoupled payments may be used to replace or complement outside credit in undertaking investment projects thereby distorting production. Our hypotheses were that AMTA payments had a direct impact on crop acres and that these payments mattered more for more highly leveraged farmers.

Like previous studies, we find that the production effects are small. Nonetheless, they suggest decoupled payments have potentially distortionary effects on production. When we take

[6] According to the Environmental Working Group database of farm payments beneficiaries, subsidy benefits for Scottie Pippen and David Letterman totaled $78,945 and $8,023 respectively for 2003-2005 Program Years (http://farm.ewg.org/).

into account time-invariant heterogeneity, when AMTA payments increase by $1,000, total crop acres increase by 3.5 to 4.7 acres, suggesting an elasticity of 0.055 to 0.074. And while owned crop acres do not seem to respond directly to these payments, they matter for the more leveraged farmer. For the individual crops whose acreage increased over the period, AMTA payments matter for soybeans and corn, with $1,000 of AMTA payments increasing acres of these crops by about 1.3 acres, implying greater elasticities than those from the total crop acres estimation using the same FE estimator. These payments did not matter for sorghum and wheat, the crops whose planted acres decreased over the period of the FAIR Act.

The analysis was performed using observations on KFMA farms over the period of the FAIR Act, which allowed us to overcome a major limitation in previous studies of the effects of decoupled payments on farmers' acreage decisions, as we were able to observe individual farms over time. We did not, however, have access to these farms' receipts of AMTA payments, and had to estimate these values given the farmers' acres in the late eighties. It is possible that over this period farmers bought or sold base acres, thereby changing their transfers. Further research would benefit from a more complete set of data. In addition, potential dynamic issues that we may have ignored remain an area for future research.

6. References

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Tables

Table 1. Variable definition and summary statistics

Variable Definitior	Variable	Observations	Mean	Std. Dev.
$Wealth_{t-1}$	Wealth ($1,000)	6,796	1,129.93	847.14
DAR_t	Debt to asset ratio	6,796	0.1682	0.1566
$AMTA_t$	AMTA payments (PFC+MLA) ($1,000)	6,796	17.95	16.34
$Size_{t-1}$	Total Operated Acres	6,796	1,788.49	1,342.08
$Acres_t$	Total Crop Acres	6,796	1,149.27	871.53
$Acres\_O_t$	Owned Crop Acres	6,796	401.16	446.04
$Acres\_Corn_t$	Acres of Corn	6,796	148.73	248.10
$Acres\_Sorghum_t$	Acres of Sorghum	6,796	178.06	238.72
$Acres\_Soybeans_t$	Acres of Soybeans	6,796	208.75	317.85
$Acres\_Wheat_t$	Acres of Wheat	6,796	381.01	408.61
$EP_{corn,t}$	Expected Corn Price ($/bu)	6,796	2.81	0.65
$EP_{sorghum,t}$	Expected Sorghum Price ($/bu)	6,796	6.09	0.92
$EP_{soybeans,t}$	Expected SoybeansPrice ($/bu)	6,796	3.97	0.54
$EP_{wheat,t}$	Expected Wheat Price ($/bu)	6,796	2.70	0.53

Table 2. Parameter estimates and summary statistics for total (owned and rented) crop acres

	OLS			FE	
Crop Acres	(1)	(2)	(3)	(4)	(5)
Farm size (acres)	0.209*	0.156*	0.158*	0.027	0.030
	(0.021)	(0.02)	(0.02)	(0.032)	(0.032)
Wealth (1,000)	0.227*	0.311*	0.306*	0.090*	0.084*
	(0.028)	(0.032)	(0.032)	(0.032)	(0.03)
Debt to asset ratio (DAR)	292.568*	260.472*	290.979*	-376.678*	-360.048*
	(60.386)	(55.103)	(56.866)	(97.648)	(101.613)
AMTA payments ($1,000)	23.446*	19.781*	20.369*	3.510**	4.710*
	(1.494)	(1.339)	(1.402)	(1.561)	(1.57)
Interaction term: DAR and AMTA	-1.545	4.194	3.799	4.900	3.074
	(3.809)	(3.378)	(3.469)	(6.457)	(6.803)
Year dummies	No	Yes	Yes	Yes	Yes
County dummies	No	Yes	Yes	-	-
Year - County dummies	No	No	Yes	No	Yes
N	5289	5289	5289	5289	5289
R2	0.6799	0.7661	0.782	0.9572	0.9652

Cluster robust standard errors in parentheses. *, **, and *** indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 3. Parameter estimates and summary statistics for owned crop acres

	OLS			FE	
Owned Crop Acres	(1)	(2)	(3)	(4)	(5)
Farm size (acres)	0.065*	0.016	0.016	-0.016	-0.008
	(0.013)	(0.013)	(0.014)	(0.024)	(0.019)
Wealth (1,000)	0.070*	0.132*	0.134*	-0.008	-0.011
	(0.024)	(0.025)	(0.026)	(0.018)	(0.015)
Debt to asset ratio (DAR)	46.397	30.361	22.883	119.250*	74.384
	(54.173)	(53.311)	(56.728)	(55.528)	(66.351)
AMTA payments ($1,000)	3.108*	2.242*	2.178**	-0.428	-1.082
	(0.968)	(0.887)	(0.956)	(1.06)	(1.067)
Interaction term: DAR and AMTA	15.707*	19.927*	20.716*	6.219***	6.472***
	(3.564)	(3.517)	(3.743)	(3.24)	(3.544)
Year dummies	No	Yes	Yes	Yes	Yes
County dummies	No	Yes	Yes	-	-
Year - County dummies	No	No	Yes	No	Yes
N	5289	5289	5289	5289	5289
R^2	0.2177	0.3804	0.4112	0.9122	0.9352

Cluster robust standard errors in parentheses. *, **, and *** indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 4. Parameter estimates and summary statistics for specific crops' acres

	OLS				FE			
Variable	Corn	Sorghum	Soybeans	Wheat	Corn	Sorghum	Soybeans	Wheat
Farm size (acres)	-0.041*	0.006	-0.039*	0.115*	0.012	-0.017	-0.005	0.021
	(0.006)	(0.007)	(0.009)	(0.011)	(0.008)	(0.017)	(0.006)	(0.02)
Expected Corn Price ($/bu)	-73.743	-72.732	-94.256	-61.769	-34.539***	-27.898	-30.334	34.375
	(63.666)	(64.365)	(86.972)	(99.545)	(20.164)	(24.214)	(20.501)	(24.072)
Expected Sorghum Price ($/bu)	-86.638**	43.548	347.524*	-291.614*	-39.115**	-45.639**	12.461	-52.880**
	(38.249)	(34.058)	(47.137)	(54.225)	(19.994)	(20.363)	(13.875)	(25.508)
Expected SoybeansPrice ($/bu)	-61.567	156.896*	605.873*	-312.990*	-52.739	-51.857***	17.113	-74.608***
	(63.18)	(57.138)	(77.826)	(88.802)	(32.239)	(27.733)	(23.549)	(41.77)
Expected Wheat Price ($/bu)	105.055	-110.957**	-604.396*	418.986*	58.237***	82.388**	-11.822	93.893**
	(68.736)	(64.152)	(87.048)	(99.089)	(35.108)	(33.918)	(24.818)	(44.739)
Wealth (1,000)	0.157*	0.038*	0.241*	-0.080*	0.023*	0.019	0.024**	0.013
	(0.015)	(0.014)	(0.021)	(0.019)	(0.009)	(0.013)	(0.011)	(0.015)
Debt to asset ratio (DAR)	122.070*	26.484	283.506*	-37.076	-7.769	-104.034*	9.658	-154.230*
	(25.057)	(38.954)	(32.342)	(41.309)	(30.525)	(39.688)	(26.52)	(52.97)
AMTA payments ($1,000)	3.465*	5.165*	-1.085***	13.335*	1.311**	0.448	1.365*	-0.953
	(0.518)	(0.635)	(0.621)	(0.845)	(0.519)	(0.85)	(0.405)	(0.741)
Interaction term: DAR and AMT	7.640*	-1.139	1.775	-7.476*	1.193	0.327	-0.111	3.707
	(1.776)	(2.643)	(1.701)	(2.806)	(1.631)	(1.654)	(0.965)	(2.547)
N	5,289	5,289	5,289	5,289	5,289	5,289	5,289	5,289
R^2	0.3565	0.2071	0.2617	0.4087	0.9085	0.7402	0.9342	0.9305

Cluster robust standard errors in parentheses. *, **, and *** indicate significance at the 1%, 5%, and 10% levels, respectively.